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I. SUMMARY

On December 23, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from USA Today (a national newspaper) concerning "an apparent high degree of miscarriages among female employees" in 1987 and 1988. The miscarriages were attributed by employees to a variety of occupational factors, including exposure to chemicals used during a recent renovation of the workplace, the use of video display terminals (VDTs), and psychological stress. In response to this request, site visits were conducted on December 21, 1988 and January 9, 1989, an environmental survey was performed on January 13-14, 1989, and a questionnaire study was initiated on February 21, 1989.

USA Today is located in a 22-story office building ("Tower I," where the miscarriages reportedly occurred) leased in Rosslyn, Virginia. The newspaper is owned by the Gannett Co., Inc., which leases an adjoining 31-story structure ("Tower II"). NIOSH's investigation was designed to identify all women who (A) worked for any length of time in Tower I or

Tower II between January 1, 1986 and February 21, 1989, and (B) became pregnant during the 1/1/86-2/21/89 time period (whether or not they actually worked in one of the buildings during their pregnancy).

A reproductive history questionnaire was completed by 583 (81%) current and 173 (33%) former female employees of USA Today and the Gannett Co., Inc. Overall, there were 108 pregnancies. Excluded from analysis were: 1 pregnancy that ended in a stillbirth, 3 tubal pregnancies, 3 pregnancies that occurred among women who were not employed during gestation, and 17 pregnancies that were electively aborted. This left a total of 84 study pregnancies that were conceived on or after January 1, 1986 and that ended before February 21, 1989. Twenty-seven (32%) of these pregnancies resulted in miscarriages. The proportions of pregnancies ending in miscarriages among women who worked (A) in Tower I, (B) in Tower II, and (C) outside of Towers I and II were 35% (34 live births, 18 miscarriages), 14% (12 live births, 2 miscarriages), and 39% (11 live births, 7 miscarriages), respectively. Women who worked in Tower I during their pregnancy were 2.4 times more likely to have miscarriages than women who worked in Tower II (95% CI=0.64-9.22), but no more likely than women who worked outside of Towers I and II (RR=0.89; 95% CI=0.45-1.77).

Among Tower I employees, more than one-half of the miscarriages occurred to women who conceived in 1988, with most occurring among those whose pregnancies started between May and September of that year. Furthermore, most of these miscarriages occurred among women who worked on the 14th and 15th floors. The proportion of pregnancies ending in miscarriages on these floors in 1988 was 100% (0 live births, 8 miscarriages). Women who conceived in 1988 and worked on the 14th or 15th floors of Tower I were 3.0 times more likely to have miscarriages than women working elsewhere in Tower I who conceived in 1988 (95% CI=1.14-7.91), and 1.8 times more likely than women who worked outside of Towers I and II and conceived

in 1988 (95% CI=0.87-3.71).

Univariate analyses demonstrated that the significant factors associated with miscarriages were working in an area under renovation (RR=2.40; 95% CI=1.35-4.27), and being 35 years of age or older (RR=2.30; 95% CI=1.30-4.08). The relative risk for miscarriages was also elevated (but not significantly) for the following factors: having had a previous miscarriage (RR=1.04; 95% CI=0.44-2.49) or induced abortion (RR=1.49; 95% CI=0.76-2.90), using a VDT for more than 20 hours per week (RR=1.40; 95% CI=0.73-2.70), and smoking (RR=1.14; 95% CI=0.52-2.49). No association was found between miscarriages and psychological stress (RR=0.89; 95% CI=0.48-1.66). A consultant's examination of drinking water found that lead levels on the 14th and 15th floors of Tower I were lower than levels found elsewhere in Towers I or II.

Multivariate analysis found that being 35 years of age or older, and working in an area under renovation were significant predictors of miscarriages.

A follow-up of 38 pregnancies ending after February 21, 1989 revealed that only 2 resulted in miscarriages and that neither miscarriage occurred among women working on the 14th or 15th floors of Tower I.

An environmental survey conducted on the 12th floor of Tower I during application of an epoxy-based floor surfacing detected low levels of xylene (10 parts per million [PPM]), 2-ethoxyethanol (1 PPM), toluene, and other substances in the work containment area. The scope of environmental monitoring for potential reproductive toxins was limited because most renovation work was completed prior to the start of this investigation.

NIOSH investigators concluded that compared to women who worked in Tower II, there was an elevated proportion of miscarriages among women who worked in Tower I, especially among those who conceived in 1988 and worked on the 14th or 15th floors. Follow-up of pregnancies ending after February 21, 1989, however, indicated that the miscarriage cluster is apparently not an ongoing problem. The precise cause of the cluster could not be determined. Most likely, it was due to either chance or other factors that could not be specifically identified. While it is possible that pregnant women may have been exposed to harmful amounts of construction-related reproductive toxins, we were unable to come up with a likely scenario by which this might have occurred.

KEYWORDS: SIC 2711 (Newspapers), miscarriage, reproduction, 2-ethoxyethanol, video display terminals, VDTs

II. INTRODUCTION

On December 23, 1988 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the publisher of USA Today. The request concerned "an apparent high degree of miscarriages among female employees" in 1987 and 1988.

III. BACKGROUND

USA Today, a national newspaper, is located on 14 floors of a 22-story office building ("Tower I") leased in Rosslyn, Virginia. The newspaper is owned by the Gannett Co., Inc., which leases 13 floors of an adjoining 31-story structure ("Tower II"). In the Fall of 1988, employees at USA Today became concerned about miscarriages among women who worked in Tower I in 1987 and 1988. The miscarriages were attributed by employees to a variety of occupational factors, including exposure to chemicals used during a recent renovation of the workplace, the use of video display terminals (VDTs), and psychological stress. In 1989, employees also became concerned that the miscarriages may have been caused by the consumption of lead-contaminated drinking water in the workplace.

To assess the problem, a USA Today/Gannett Co., Inc. Health/Workplace Task Force (consisting of management and employee representatives) was established and the assistance of NIOSH requested. In response to this request, NIOSH conducted: site visits (including walk-through inspections and medical interviews) on December 21, 1988 and January 9, 1989; an environmental survey on January 13-14, 1989; and a questionnaire study (beginning) on February 21, 1989. A letter summarizing the January 9th visit was issued on January 18, 1989.

IV. METHODS

A. Overview

A study was designed to identify the proportion of pregnancies that ended in miscarriages among women who (A) worked for any length of time in Tower I or Tower II between January 1, 1986 and February 21, 1989, and (B) became pregnant during the 1/1/86-2/21/89 time period (whether or not they actually worked in one of the buildings during their pregnancy).

The names and addresses of 721 current and 538 former employees eligible for the study were provided to NIOSH by USA Today and the Gannett Co., Inc. Employees of Grant Tinker Gannett, the broadcasting division of the Gannett Co., Inc., were not included in the study because their names were excluded from the initial employee roster that NIOSH received.

B. Medical/Epidemiologic

1. Questionnaire

On February 21-23, 1989, a two-part, self-administered questionnaire was completed in Towers I and II by current

female employees of USA Today and the Gannett Co., Inc. (A blank copy of the questionnaire is available, on request, from NIOSH.) Subsequently, the questionnaire was mailed to current employees who had not completed it. Part A, which was filled out by all participants, elicited demographic data and information on work-related psychological stress. Part B, which was completed by women who had pregnancies that began on or after January 1, 1986, contained questions pertaining to reproductive, medical, and occupational histories.

A questionnaire was then mailed to the homes of all former female employees of USA Today and the Gannett Co., Inc. who had worked for any length of time in Tower I or Tower II between January 1, 1986 and February 21, 1989. (The 1986-1989 time period was chosen because company representatives indicated that they did not have up-to-date addresses for women who left employment prior to 1986.) An attempt was made to verify addresses with the U.S. Postal Service prior to the questionnaire being sent out. If employees did not respond within 2-3 weeks, a second questionnaire was sent. In addition, a form was sent on which employees could anonymously indicate why they did not wish to participate in the study (if that was the course of action they chose).

All pregnancies that began on or after January 1, 1986 and ended in a live birth or miscarriage before February 21, 1989 were considered for analysis. Stillbirths, tubal pregnancies, pregnancies that occurred when women were not employed, and pregnancies that were electively aborted were excluded. (The tubal pregnancies and pregnancies that were electively aborted were excluded because they did not have a "chance" to miscarry. The pregnancy that ended in a stillbirth and the pregnancies that occurred among women who were not employed were excluded because there were too few of these events to analyze.) A miscarriage was defined as a self-reported fetal death within the first 20 weeks of gestation. A stillbirth was defined as a self-reported fetal death after 20 weeks of gestation.

The proportions of pregnancies ending in miscarriages [miscarriages/(live births + miscarriages)] were compared (A) by the work location during pregnancy (i.e. in Tower I, in Tower II, or outside of Towers I and II); (B) by the year of conception; and (C) by the floor worked on, for women who conceived in 1988 and worked in Tower I.

Separate analyses were carried out for (1) all pregnancies that occurred between January 1, 1986 and February 21, 1989, irrespective of the number of pregnancies to an individual mother; (2) first pregnancies that occurred during the 1986-1989 period to individual mothers; and (3) pregnancies that ended in "documented" miscarriages (as explained below). Statistical testing of univariate comparisons included chi square tests of homogeneity for dichotomous risk factors and Student's t-test for continuous variables.¹ Multivariate comparisons were made using an unconditional logistic regression model.² Variables included in the multivariate analysis were those thought to be potential risk factors for miscarriage, including working in an area under renovation, conception in 1988, age (as a continuous and dichotomous variable), history of previous induced abortion, VDT use, smoking, history of previous miscarriage, and stress. The final model included only those variables

that were found to be statistically significant or that had a strong effect on the other variables in the model. First order interactions were tested, but none were significant. Finally, the miscarriages representing the "cluster" were removed and the multivariate analysis repeated. This was done to examine the reliability of the predictor variables.

2. Miscarriage Risk Factors

In the questionnaire, data were collected on the following possible miscarriage risk factors: medications, illnesses, and injuries; smoking; the consumption of alcohol; the use of VDTs; and exposure to chemicals used during workplace renovation.

Workplace renovation, in selected areas of Tower I and Tower II, occurred between 1986 and 1989. (Most renovation took place in Tower I.) On the 14th and 15th floors of Tower I, construction work was done between March 1988 and January 1989. In general, renovation consisted of demolition (walls and partitions), drywall installation, painting, and the installation of carpeting and furniture. In addition, on the 12th floor of Tower I, an epoxy-based floor surfacing was applied on 3 separate occasions (July 1988, September 1988, and January 1989). Application of the surfacing involved the use of 2-ethoxyethanol, a solvent that has been shown to be a reproductive toxin in animal studies (see section V.C.1.a. of this report). Most renovation work was completed prior to NIOSH's initial site visit.

3. Review of Medical Records

To document or verify fetal loss, the medical records of women who had miscarriages were obtained. A miscarriage could be documented by medical records containing (A) a pathology or ultrasound report consistent with fetal loss or (B) a physician's diagnosis of spontaneous abortion. After a review of available medical records, the percentage of questionnaire-reported miscarriages that could be documented was calculated.

4. Review of Disability and Insurance Records

To determine the number of pregnancies and miscarriages among female employees who did not participate in the study, (A) USA Today and Gannett Co., Inc. disability records were reviewed, and (B) the major insurance companies providing coverage for employees were asked to send listings of all pregnancy-related claims for the January 1, 1986-February 21, 1989 time period to NIOSH. After an examination of these records, determinations were made of (1) the number of pregnancies and miscarriages that were listed in questionnaires and disability/insurance records, (2) the number of pregnancies and miscarriages that were listed only in disability/insurance records, and (3) the number of pregnancies and miscarriages that were listed only in questionnaires.

5. Survey of Pregnancies Conceived During Study Period (1/1/86-2/21/89) and Ending After February 21, 1989

Pregnancies that were conceived during the study period, 1/1/86-2/21/89, but that did not end prior to February 21, 1989 (the end of the study period), were excluded from the primary analysis. However, a follow-up telephone survey was conducted to obtain information on the outcome of these pregnancies.

During the weeks of December 12, 1989, December 19, 1989, and February 26, 1990, telephone calls were made to 30 current and former employees who completed questionnaires and were still pregnant on February 21, 1989.

C. Industrial Hygiene

NIOSH investigators reviewed (A) the environmental monitoring conducted by a company consultant on November 28-29, 1988, (B) the testing of VDTs done by another consultant on December 15, 1988, and (C) the analysis of drinking water for lead performed by a third consultant on February 26, 1989 and March 4-5, 1989.

The third consultant collected water samples from Towers I and II and analyzed them for lead. The samples - from drinking fountains, restroom faucets, galley sink faucets, and ice - were of standing water and "purged" water (i.e., water that was allowed to run for 5 minutes prior to collection). To determine if there was an association between miscarriages and the consumption of lead-contaminated drinking water, NIOSH investigators compared mean lead levels (A) between Tower I and Tower II, and (B) within Tower I, between floors 14/15 and all other floors.

On January 13-14, 1989, NIOSH investigators conducted air sampling on the 12th floor of Tower I, where an epoxy-based floor surfacing was being applied. The purpose of the sampling was to determine the concentration of airborne contaminants and the likelihood of the contaminants escaping from the area under renovation to other parts of the building. (The air sampling and analysis methods used are summarized in Appendix I.). In addition, material safety data sheets (MSDSs) for substances used during application of the floor surfacing were examined, as were the phases of renovation (on a floor by floor, month by month basis). The renovation review was used to determine if employees had worked in areas under construction during their pregnancies.

V. GENERAL INFORMATION ON MISCARRIAGES

A. Reproductive Studies

It is not known what causes most miscarriages. Many factors have been implicated (chromosomal abnormalities, endocrinological problems, deformities of the uterus or cervix, etc.), but few have been proven beyond doubt to cause fetal loss.

Proving a causal association between workplace conditions and miscarriages is extremely difficult. There are several reasons for this:³ (A) medical knowledge about the effect of workplace exposures on pregnancy is very limited; (B) in most workplaces there are many different types of exposures (chemical, physical, biological) and it is difficult to separate the effects of each; (C) women who have had miscarriages may have a greater tendency to recall specific

exposures than women who have not had miscarriages (recall bias, which can lead to an exaggeration of the association between exposures and miscarriages); (D) for statistical reasons, large numbers of miscarriages must be included in any study if etiological inferences are to be made; and lastly, (E) non-occupational miscarriage risk factors may contribute to fetal loss and may be difficult to separate from work-related ones.

Several investigators have attempted to study occupation and pregnancy outcome. McDonald studied 22,613 pregnancies in Montreal and found a slightly increased miscarriage rate among sales sector and service sector personnel, and a substantially increased rate among operating room nurses, radiology technicians, and employees in agriculture and horticulture.⁴ Postulated causes for the increased rates included high levels of physical stress (weight lifting, standing) and exposure to solvents (in the manufacturing sector). Ahlborg studied 5,644 pregnancies in Sweden and did not find miscarriage rates to vary among different occupations.⁵ In both studies, clerical and managerial personnel did not have increased miscarriage rates.

B. Miscarriage Clusters

A cluster is an unexpected grouping of events. It may be due to (A) local variations in diagnosis, (B) local variations in gene pools, (C) local demographic or socio-economic conditions, (D) random phenomena (i.e. chance), or (E) specific environmental agents.⁶ The probability of a miscarriage cluster occurring in any single group of women is low. However, in a large number of groups, clusters are likely to be found.⁷ For example, concerning VDTs and miscarriages, it has been estimated that if 7 million VDT users were arbitrarily divided into 100,000 groups of 70 workers each, over a 2-year period 613 of these groups could be expected to have a two-fold increase in miscarriages on the basis of chance alone.⁸

Over the last 10 years, NIOSH has investigated over 40 possible clusters of adverse reproductive outcomes, including miscarriages. The investigations have included office and factory workers. The risk factors assessed have ranged from chemicals to radiation. Of the 43 investigations reviewed, in 28 (66%) no excess risk of adverse reproductive outcome could be detected. (Either some of the reported adverse outcomes did not occur, or the perceived cluster did not represent a statistically significant excess.) In 7 (16%), it was unclear if the problem existed. In 8 (18%), it was determined that the cluster of adverse reproductive outcomes (birth defects [1 study], infertility [3 studies], and miscarriages [4 studies]) had, in fact, occurred. In the 4 instances in which miscarriage clusters were documented, however, causes could not be determined.

C. Selected Miscarriage Risk Factors

1. Airborne Chemical Contaminants

According to a 1979 review article, "risks to the offspring of workers with occupational chemical exposures may derive from mutagenic, teratogenic or carcinogenic effects of industrial agents to which the parents are exposed. Evidence for impaired pregnancies and hazards to the offspring of working populations with chemical exposures is,

however, very limited."⁹

The following chemicals are discussed here because they were found to be present during air sampling on the 12th floor of Tower I. This does not imply, however, that USA Today or Gannett Co., Inc. employees were exposed to them. That issue will be discussed later in this report.

a. 2-Ethoxyethanol

2-Ethoxyethanol (2EE) has caused significant, dose-related, adverse reproductive effects in animals.¹⁰ In female rats and rabbits, it has caused embryonic death and fetal developmental abnormalities. In males, it has produced testicular atrophy in mice and microscopic testicular changes in mice, rats, and dogs. Unfortunately, the only published investigation of reproductive outcome in humans exposed to 2EE is difficult to interpret because of mixed exposures. NIOSH recommends that 2EE be regarded as having the potential to cause adverse reproductive effects in male and female workers.¹⁰ Since it cannot be assumed that there are safe concentrations for humans, employers are urged to assess how their workers may be exposed to 2EE and to reduce exposures to the lowest extent possible.¹⁰

The Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limit (PEL) for 2EE, which is currently under review, is 200 parts per million (PPM) as an 8-hour time-weighted average (TWA)¹¹ (Appendix II). The reproductive effects noted above, however, have been reported at concentrations less than this PEL.¹⁰ The American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Value (TLV) is 5 PPM.¹²

b. Toluene

Limited studies suggest that in rats and mice, toluene (in very high dosages) is harmful to fetuses, causing reductions in weight, retarded ossification of bones, skeletal anomalies, and death.¹³ These studies, however, are not adequate to assist in drawing conclusions about the reproductive toxicity of toluene in the occupational setting.¹³

The NIOSH Recommended Exposure Limit (REL), OSHA PEL, and ACGIH TLV for toluene are 100 PPM, 200 PPM, and 100 PPM, respectively.^{11,12,14}

c. Xylene

In rat studies, xylene (in very high dosages) has caused the death of embryos and has been harmful to fetuses, resulting in reductions in weight, retarded ossification of bones, skeletal anomalies, and delayed kidney development.¹³ Unfortunately, there have been no studies in humans looking at the effect of xylene on reproduction.¹³

The NIOSH REL, OSHA PEL, and ACGIH TLV for xylene are all 100 PPM.^{11,12,14}

d. Other

Animal studies suggest that many other chemicals (in relatively high dosages), including hexane, methylstyrene, naphthalene, and trichloroethane, may cause a variety of adverse reproductive outcomes. However, the evidence from these studies is not conclusive and cannot be extrapolated to humans.

2. Lead

The effect of lead on reproduction is unclear. Early studies indicated that exposure to high levels of lead could cause miscarriages and stillbirths in women.¹⁵ These studies, however, did not define the effects of more limited exposures (such as those that might occur from drinking lead-contaminated water).¹⁵

A recent investigation that compared miscarriage rates among women living in the vicinity of a lead smelter (and having limited, but definite, exposure to lead) to the rates among women living in a nearby town, did not find women in the former group to be at increased risk of having miscarriages.¹⁶ (The mean blood lead levels of the two groups were 15.9 and 5.1 micrograms/deciliter [ug/dL], respectively.) A similar study looking at pregnant women living near a lead smelter in Australia (with mean blood lead levels ranging from 10.6-11.2 ug/dl) also found no association between maternal blood lead levels and miscarriages.¹⁷

In summary, modest exposure to environmental lead has not been shown to cause miscarriages.

3. Video Display Terminals (VDTs)

VDTs produce several types of electromagnetic radiation. Low-energy X-rays (ionizing radiation) are generated in the cathode ray tube of the VDT; ultraviolet, visible, and infrared radiation (non-ionizing radiation) are emitted by the phosphor material of the screen; and radiofrequency, very low frequency, and extremely low frequency radiation (also non-ionizing) are produced by the electronic circuits and components.¹⁸

Several researchers have evaluated VDTs for possible radiation hazards to workers. Measurements of over 2,300 VDTs have largely found levels of ionizing radiation to be no greater than background levels.¹⁸ The known adverse reproductive effects from ionizing radiation have only been documented at dosages well above this.

Concerning non-ionizing radiation, attention has centered on radiofrequency radiation and extremely low frequency radiation.¹⁸ Radiofrequency radiation in high dosages can adversely affect reproductive outcome. The levels emitted from VDTs, however, have been found to be quite low.

The situation regarding extremely low frequency radiation (ELFR) is not as clear.¹⁸⁻¹⁹ In experimental studies, certain types of ELFR - types that

are similar, but not identical, to the ELFR emitted from VDTs - have adversely affected chick embryos. It has not been possible, however, to extrapolate these findings to humans. In a case-control study of 1,583 pregnant women in Northern California, a significantly elevated risk of miscarriage was found among women who reported using VDTs for more than 20 hours per week during the first trimester of pregnancy.²⁰ This finding, however, has not been demonstrated in other studies.²¹

VI. RESULTS

A. Medical/Epidemiologic

1. Questionnaire Study

a. Participation

Eighty-four percent (285) of current USA Today female employees completed questionnaires, as did 78% (298) of Gannett Co., Inc. workers. Overall, 81% (583) of current employees participated in the study.

Among former employees, 34% (92) of those who worked at USA Today and 32% (81) of those who worked at the Gannett Co., Inc. completed questionnaires. Overall, 33% (173) of former employees participated in the study. (Questionnaires were not successfully delivered to 185 former employees, either because mailing addresses were incorrect or because the questionnaires were not claimed at the post office. When women who did not receive questionnaires are excluded, the response rates for former employees become 48% [USA Today], 51% [Gannett Co., Inc.], and 51% [overall]).

Forty-seven employees returned forms indicating why they did not wish to participate in the study. Twenty felt that the issue "did not concern" them, 8 believed that the questions being asked were too personal, 10 were concerned about confidentiality, and 9 listed other reasons.

b. Demographics

The mean age of current and former employees who participated in the study was 32 years (as of February 21, 1989) (Table 1A). Overall, 552 (74%) were white, 166 (22%) were black, 17 (2%) were Asian, 12 (2%) were Hispanic, and 2 (<1%) were American Indian/Alaskan native. (Seven women did not indicate their race.) Concerning education, 50 (7%) completed high school, 39 (5%) had technical or vocational training after high school, 502 (67%) completed 1-4 years of college, and 161 (21%) did graduate work. (Four women did not indicate their level of education.)

The mean ages of current and former employees who were pregnant during the 1986-1989 period were 32 years and 31 years, respectively (as of February 21, 1989) (Table 1B).

Overall, the mean age was 32. Fifty-two (72%) were white, 15 (21%) were black, 4 (6%) were Asian, and 1 (1%) was Hispanic. (One person did not indicate her race.) Concerning education, 6 (8%) of the pregnant participants completed high school, 5 (7%) had technical or vocational training after high school, 49 (67%) completed 1-4 years of college, and 13 (18%) did graduate work. Thus, the pregnant participants were demographically similar to the overall cohort of study participants.

c. Miscarriage Proportions

Overall, there were 108 pregnancies. Excluded from analysis were: 1 pregnancy that ended in a stillbirth, 3 tubal pregnancies, 3 pregnancies that occurred among women who were not employed during gestation, and 17 pregnancies that were electively aborted. This left a total of 84 pregnancies that began on or after January 1, 1986 and that ended before February 21, 1989. Twenty-seven (32%) of these pregnancies resulted in miscarriages.

The proportions of pregnancies ending in miscarriages for women who worked (A) in Tower I, (B) in Tower II, and (C) outside of Towers I and II (for companies other than USA Today and the Gannett Co., Inc.) during their pregnancy were 35% (34 live births, 18 miscarriages), 14% (12 live births, 2 miscarriages), and 39% (11 live births, 7 miscarriages), respectively (Table 2). For first pregnancies, the miscarriage proportions were 32%, 20%, and 39%, respectively. For documented miscarriages, the miscarriage proportions were 31%, 0%, and 27%, respectively. Women who worked in Tower I during their pregnancy were 2.4 times more likely to have miscarriages than women who worked in Tower II (all pregnancies; 95% CI=0.64-9.22), but no more likely than women who worked outside of Towers I and II (RR=0.89; 95% CI=0.45-1.77).

Among Tower I employees, more than one-half of the miscarriages occurred among women who conceived in 1988 (Table 3), with most occurring among women whose pregnancies started between May and September of that year (Figure 1). Furthermore, most of these miscarriages occurred among women who worked on the 14th and 15th floors. The proportion of pregnancies ending in miscarriages on these floors in 1988 was 100% (0 live births, 8 miscarriages) (Table 4). Women who conceived in 1988 and worked on the 14th and 15th floors of Tower I were 3.0 times more likely to have miscarriages than women working elsewhere in Tower I who conceived in 1988 (95% CI=1.14-7.91), and 1.8 times more likely than women who worked outside of Towers I and II and conceived in 1988 (95% CI = 0.87-3.71). (To estimate these relative risks, 1 pregnancy was added to each cell of the 2x2 contingency tables.) The 8 miscarriages among employees who conceived in 1988 and worked on the 14th and 15th floors of Tower I were suffered by 6 women. (Two women had multiple miscarriages.) Two miscarriages were attributed to chromosomal abnormalities, 1

occurred five weeks after an endometrial biopsy (performed when it was erroneously thought that the patient was not pregnant), and 5 were of unknown etiology. The average age of the 5 women who had miscarriages of unknown etiology was 31 years. Fetal loss occurred at 7, 8, 9, 16, and 20 weeks of gestation in these women. (The average age of the other 3 women was 36, with fetal loss occurring at 9, 11, and 11 weeks.) All pregnancies were said to have overlapped in time with office renovation.

Univariate analyses demonstrated that the significant factors associated with miscarriages were working in an area under renovation (RR=2.40; 95% CI=1.35-4.27), conceiving in 1988 (RR=2.32; 95% CI=1.29-4.18), and being 35 years of age or older (RR=2.30; 95% CI=1.30-4.08) (Table 5). (When the association between miscarriages and working in an area under renovation during the first 20 weeks of pregnancy is calculated, the relative risk is 2.52 [95% CI=1.43-4.48].) The relative risk for miscarriages was also elevated (but not significantly) for having had a previous miscarriage (RR=1.04; 95% CI=0.44-2.49) or induced abortion (RR=1.49; 95% CI=0.76-2.90), using a VDT for more than 20 hours per week (RR=1.40; 95% CI=0.73-2.70), and smoking (RR=1.14; 95% CI=0.52-2.49). An elevated risk was not observed for psychological stress (RR=0.89; 95% CI=0.48-1.66) or the consumption of lead-contaminated drinking water (see section VI.B.1., below).

(N.B. All 84 study pregnancies to current and former employees were included in the analyses, whether or not the pregnancies actually occurred while the mothers were working in Tower I or Tower II. For women who worked outside of Towers I and II during their pregnancy, vis à vis renovation, it was assumed that there was no exposure. If only pregnancies occurring during employment in Tower I or Tower II are analyzed, the relative risk for working in an area under renovation is 3.21 [95% CI=1.55-6.67].)

When all 84 study pregnancies were included, the multivariate model which best predicted miscarriages included 2 variables: being 35 years of age or older (OR=5.68; 95% CI=1.62-19.92), and working in an area under renovation (OR=5.42; 95% CI=1.77-16.57). (N.B. The odds ratios should be interpreted with caution, because in logistic regression when the outcome being studied is not a rare event [as it is not in this case, with miscarriages having a prevalence of about 30%], the odds ratio overestimates the relative risk.) Previous miscarriages and induced abortions, VDT use for 20 or more hours per week, smoking, and stress did not contribute to the multivariate model. When age was entered into the model as a continuous variable, there was no appreciable change.

In order to investigate the above factors outside of the actual cluster, the 8 miscarriages that occurred among women who conceived in 1988 and worked on the 14th or 15th floors of

Tower I were subsequently removed and the multivariate analysis repeated. Being 35 years of age or older remained significantly associated with miscarriages (OR=4.67; 95% CI=1.22-17.84). However, being in an area under construction was no longer significant (OR=2.07; 95% CI=0.52-8.25).

2. Review of Medical Records

On the questionnaire, 25 employees reported having had a total of 27 miscarriages. (Two employees had multiple miscarriages.) Medical records documenting fetal loss were obtained for 18 of the 26 reported miscarriages for which medical care was sought. (One woman who did not seek care reported having had a "heavy period" a few weeks after a positive home pregnancy test.) Overall, therefore, 18 (67%) of the 27 miscarriages reported on the questionnaire were documented in medical records. The percentage of documented miscarriages for women working (A) in Tower I, (B) in Tower II, and (C) outside of Towers I and II were 83%, 0%, and 43%, respectively. Among the 8 miscarriages suffered by 14th and 15th floor Tower I employees who conceived in 1988, 6 (75%) were documented. In no case did a medical record show that a reported miscarriage had not occurred. The review of medical records suggests that questionnaire reports of miscarriages were accurate. (We had no way, however, of verifying the accuracy of questionnaires indicating no miscarriages.)

The presumed causes of miscarriages noted on medical records included chromosomal abnormalities in 3 cases. In addition, one woman miscarried 5 weeks after an endometrial biopsy. Medical records did not verify the "chromosomal problem" reported on the questionnaire of one woman or the "congenital anomalies" reported by two other women. (The stillbirth, which was excluded from analysis, occurred at 21 weeks of gestation to a woman who developed premature rupture of membranes during a long-distance airplane flight.)

Medical records were also obtained for two women who had "elective" abortions on the suggestion of their physicians. In one woman, the "abortion" was actually a therapeutic "D and C" (dilatation and curettage) following a miscarriage. In the other woman, the abortion was induced because the fetus had an invariably fatal condition.

3. Review of Disability and Insurance Records

According to disability and insurance records, there were 89 pregnancies (excluding those that were electively aborted) among USA Today and Gannett Co., Inc. female employees that started on or after January 1, 1986 and ended before February 21, 1989. Fourteen of these resulted in miscarriages, 1 ended in a stillbirth, and two were ectopic.

Fifty-eight (65%) of these pregnancies and 9 (64%) of these miscarriages were reported in questionnaires. Questionnaires were not completed by women accounting for the remaining 31 pregnancies and 5 miscarriages. (If current and former employees who did not participate in the study had had the same fertility rates and miscarriage proportions as women who completed questionnaires, there would have been 70 pregnancies

and 19 miscarriages among non-participants.)

The disability and insurance company data had several limitations:

- a. The information was incomplete. Twenty-six pregnancies and 18 miscarriages reported in questionnaires were not contained in disability or insurance data. The possible reasons for this are threefold: not all employees may have qualified for disability; not all employees may have chosen to tell their employers about their pregnancies and medical problems; and some employees may have used insurance companies other than those contacted by NIOSH investigators (such as companies providing coverage through spouses).
- b. The form in which the information was provided lacked detail, forcing NIOSH investigators to "interpret" much of it. (For example, four women had insurance claims for "pregnancy." For purposes of this investigation, it was assumed that these pregnancies did not end in miscarriages. This assumption, however, cannot be made with certainty without reviewing medical records.)

4. Survey of Pregnancies Conceived During the Study Period (1/1/86-2/21/89) and Ending After February 21, 1989

Telephone contact was made with 22 current and 6 former female employees who were still pregnant on February 21, 1989 to determine pregnancy outcome. One current and 1 former employee could not be reached.

Overall, among these 28 women, 26 pregnancies ended in live births, 1 ended in a miscarriage, and 1 ended in a stillbirth. Eighteen of the live births occurred among women who worked in Tower I (including 1 to a 15th floor employee), 3 occurred among women who worked in Tower II, 4 occurred among women who worked outside of Towers I and II, and 1 occurred to a woman who was not employed during her pregnancy. The miscarriage was suffered by a current Tower II employee and the stillbirth by a former employee who worked outside of Towers I and II during her pregnancy. In addition, according to questionnaires, there were 10 other pregnancies that were conceived during the study period and that ended after February 21, 1989. One resulted in a miscarriage (to a Tower II employee) and 9 ended in live births (1 to a woman who worked on the 15th floor of Tower I, 4 to women who worked outside of Towers I and II, and 4 to women who were not employed during their pregnancies).

In total, then, there were 38 pregnancies that were conceived during the study period and that ended after February 21, 1989. Thirty-five (92%) of these pregnancies ended in the birth of children (including 2 to women who worked on the 15th floor of Tower I), 2 (5%) ended in miscarriages (to women working in Tower II), and 1 (3%) ended in a stillbirth. (N.B. These pregnancies were not included in the primary analysis of the 84 study pregnancies.)

B. Industrial Hygiene

1. Review of Previous Surveys and Tests

Environmental monitoring was conducted by a consultant on November 28-29, 1988, for 6 gaseous chemicals (carbon monoxide, carbon dioxide, formaldehyde, ozone, oxides of nitrogen, and mercaptans), halogenated hydrocarbons (including pesticides such as chlordane, chlorpyrifos, and aldrin), other hydrocarbons (including benzene, toluene, and chloroform), and asbestos. The consultant concluded that "no significant concentration of the chemical agents tested for were found to be present at the time of sample collection." (NIOSH did not review the actual sampling data.)

VDT testing was done by another consultant on December 15, 1988. The consultant concluded that no VDT-related radiation hazards could be found.

A third consultant performed an analysis of drinking water for lead on February 26, 1989 and March 4-5, 1989. Overall, 195 samples were taken. In most samples of standing water and purged water from drinking fountains, the lead content exceeded the current Environmental Protection Agency standard of less than or equal to 50 parts per billion. Mean lead concentrations were lower in Tower I than in Tower II, and within Tower I were lower on the 14th and 15th floors than on other floors (Table 6A). Concerning other sources of water, such as restroom faucets and galley sink faucets, similar results were found (Table 6B).

In addition, 39 employees from Tower I and Tower II had blood samples taken for lead and zinc protoporphyrin (ZPP) analysis. (An elevated ZPP is one of the earliest indicators of lead toxicity.) Thirty of these results were reported to NIOSH. All lead levels were less than 12 micrograms per deciliter (mcg/dL), with the majority (28) being less than the limit of detection (5 mcg/dL). A "normal" lead level is considered to be less than or equal to 20 mcg/dL.²³ All ZPP levels were less than 46 mcg/dL, with the majority (28) being below 34. A "normal" ZPP level is 16-36 mcg/dL.²³ (The two women with elevated ZPP levels had lead levels below the limit of detection, making it unlikely that the ZPP elevations were related to lead exposure. In women without occupational exposure to lead, the most likely cause of an elevated ZPP is iron deficiency.)

2. Review of Construction Records

USA Today and the Gannett Co., Inc. provided floor-by-floor, phase-by-phase renovation schedules for all construction work that took place in Tower I and Tower II between 1986 and 1989. The information was used to verify whether or not employees worked in areas that were under renovation during their pregnancies. (We presumed that records were more accurate than questionnaire data with respect to dates of construction work.)

According to the questionnaire, 21 pregnancies (accounting for 10 live births and 11 miscarriages) occurred while women were working in

areas that were under renovation. Construction records corroborated this in 15 cases. In 6 cases (5 successful pregnancies and 1 miscarriage), they did not. Forty-five pregnancies (accounting for 36 live births and 9 miscarriages) were said to have occurred (among Tower I and Tower II employees) while women were not working in areas that were under renovation. Construction records verified this in 40 cases. In 5 cases (4 successful pregnancies, 1 miscarriage), the records indicated that there may have been renovation going on.

Univariate analysis of the association between working in an area under renovation and miscarriages, using the construction records, produced a relative risk (RR) of 2.56 (95% CI=1.45-4.52). This is similar to RR of 2.40 obtained from questionnaire-derived exposure information.

3. Environmental Survey

On January 13-14, 1989, during a weekend when employees were not in the area, environmental monitoring was conducted during application of an epoxy-based floor surfacing on the north end/west side of the 12th floor of Tower I (Production Area). The installation sequence involved the application of a polyurethane membrane, a primer, a mortar, and an epoxy coating. A stairwell was situated adjacent to the installation area. Prior to the work, contractors constructed a containment area using polyethylene sheeting for walls and a door. The area was kept under negative pressure (i.e. all air flow was into the contained area) with 2 fans that exhausted air to the outside at a rate of 800 cubic feet per minute. The floors's main air handling equipment was turned off.

According to a representative of the Gannett Co., Inc., during the previous applications of the same type of floor surfacing on the 12th floor of Tower I (on July 29-31, 1988 and September 23-25, 1988), the main air handling equipment was left running, causing a spread of fumes on the 12th floor.

Samples for airborne contaminants from the flooring system were collected (A) inside the containment area, (B) on the 12th floor just outside the containment area, and (C) on the 14th and 15th floors. (N.B. There is no 13th floor.) The air samples on the 14th and 15th floors were collected near the stairwell connecting these floors to the 12th floor. (As each floor has separate air handling systems, the only way contaminants could spread between floors was via stairwells.)

Air samples collected during the application were analyzed for organic compounds. The results (in the form of chromatograms) for the samples collected (A) inside the containment area, and (B) on the 12th floor just outside the containment area, are shown in Figures II and III. Inside the containment area, xylene, toluene, and other compounds were found. Outside the containment area, similar substances were present, though in lower concentrations. On the 14th and 15th floors, an analogous array of analytes was detected, but in even smaller amounts.

Air samples were also collected specifically for dibutyl phthalate, diethylene triamine, 2-ethoxyethanol, methylene dianiline, and xylene (i.e. potentially hazardous substances listed in MSDSs). 2EE was

measured in the containment area at a concentration of 1 PPM, but was not detected in any other areas. Xylenes were measured in the containment area at 10 PPM and just outside the containment area at 0.03 PPM, but were not detected on the 14th or 15th floors. None of the other compounds tested for were detected in any samples.

In general, airborne contaminants generated during the application of the epoxy-based flooring on January 13-14, 1989 were well-controlled.

VII. DISCUSSION

As initially reported to NIOSH by the USA Today/Gannett Co., Inc. Health/Workplace Task Force, there appears to have been an unusual cluster of miscarriages among women who conceived in 1988 and worked on the 14th and 15th floors of Tower I. The etiology of this cluster could not be definitively determined.

Possible explanations for the cluster include the following:

- A. The cluster may have been due to chance.
- B. The cluster may have been due to factors that were not identified by investigators.
- C. The cluster may have been related to renovation in one of two ways:
 - 1. In theory, it is possible that construction-related exposures on the 14th and 15th floors differed from those in other areas. The miscarriage-causing exposure (or exposures) being postulated, however, would have had to have been toxic enough and to have been present in high enough concentrations to adversely affect the majority of pregnant women exposed to it. While it is impossible to determine the precise likelihood of this scenario, given what we know about the renovation work that was done, it does not seem highly probable.
 - 2. Alternatively, the cluster may have been due to exposure to 2EE. NIOSH investigators focused on the use of 2EE, a solvent used in the application of epoxy-based floor surfacings, because animal studies indicate that 2EE is a reproductive toxin.¹⁰ Construction records revealed that 2EE was used on the 12th floor of Tower I on 3 separate occasions: July 29-31, 1988, September 23-25, 1988, and January 13-15, 1989.

Because the cluster of miscarriages occurred on the 14th and 15th floors of Tower I in 1988, it was initially postulated that 2EE may have spread to these areas from the 12th floor. Therefore, an examination was made of pregnancies on the 12th floor and pregnancies on the 2 floors above (14, 15) and below (10, 11) floor 12. (There is no 13th floor.) Overall, of the 9 pregnancies on floors 10-15 whose first 20 weeks overlapped in time with the first and/or second applications of 2EE, 6 ended in miscarriages (RR=2.38; 95% CI=1.32-4.28), with 2 being due to chromosomal abnormalities and 4 being of unknown etiology. Of the 6 pregnancies that overlapped in time with the third application of

2EE (when additional measures were taken to reduce exposure), none ended in miscarriages.

In the environmental survey conducted during the third application of 2EE, levels of 2EE were extremely low within the containment area (1 PPM) and were not detected outside the containment area. We do not know if 2EE exposure occurred outside this area during the first or second applications. In theory, 2EE could have escaped from the containment area, migrated to nearby floors via stairwells, and adversely affected pregnant women. However, given the low likelihood of significant concentrations of 2EE reaching the 14th and 15th floors (each floor has an independent ventilation system and the only route of dissemination would have been via stairwells), this scenario also does not seem probable.

Questionnaire responses and the telephone survey indicated that among the 38 pregnancies conceived during the study period and ending after February 21, 1989, there were only 2 miscarriages. Both were suffered by women working in Tower II. Of the successful pregnancies, 19 occurred among women working in Tower I, including 2 among women working on the 15th floor. In addition, according to an employee of USA Today, there have been 3 other successful pregnancies (and no miscarriages) among 14th and 15th floor personnel who conceived after February 21, 1989. (This latter information, however, has not been confirmed by NIOSH investigators.) All of this suggests that a miscarriage problem apparently no longer exists among women on the 14th and 15th floors of Tower I.

Concerning study design, several limitations are recognized in this investigation. Potential sources of bias (i.e. systematic errors in design, conduct, or analysis of the study) that could have resulted in a mistaken estimate of the association between exposures (such as to chemicals used during renovation) and miscarriages include response bias, recall bias, and case misclassification.

Response (Participation) Bias

The participation rate of former employees (33%) was much lower than that of current employees (81%). This may have resulted in an underreporting of successful pregnancies. Women who had successful pregnancies may have left employment and been lost to follow-up more often than those whose pregnancies ended in miscarriages. Also, former employees who had miscarriages may have been more motivated to participate in the study than those who had live births. These factors could have resulted in an overestimation of miscarriage proportions, especially for women who worked outside of Towers I and II (56% of these women were "former" employees, compared to 23% of women who worked in Tower I and 43% who worked in Tower II), and an exaggeration of the effect of various exposures on miscarriages. The disability and insurance data, which showed that non-participants may have had lower miscarriage proportions than study participants, are consistent with the existence of a response bias.

Recall Bias

In reproductive studies, women who have suffered miscarriages may - because

they have previously thought about it - recall exposures they had during pregnancy (i.e. to chemicals, VDTs, and other factors) that women who have had successful pregnancies do not. In this investigation, recall bias concerning exposure to renovation (the most obvious "foreign" exposure at work) occurred - with superior recall among women who had miscarriages. Among women who had miscarriages, construction records verified questionnaire-reported exposures to renovation in 10 out of 11 cases. Among women who had live births, construction records verified questionnaire responses in only 5 out of 10 cases. When the association between miscarriages and working in an area under renovation is recalculated using these records, however, the relative risk only changes slightly, from 2.40 (95% CI=1.35-4.27) to 2.56 (95% CI=1.45-4.52). Recall bias was not examined for other exposures.

Case Misclassification

With the exception of one woman who did not seek medical care at the time of her miscarriage (and who diagnosed her pregnancy with a home pregnancy kit), all employees who suffered miscarriages indicated that they had seen physicians when they experienced fetal loss. Medical records verifying these physician-patient encounters were obtained for 67% of miscarriages (including 83% of those in Tower I). In no case did medical records show that a reported miscarriage had not occurred. Thus, case misclassification seems to be an unlikely explanation for the high proportions of miscarriages in this study.

It should be noted that case misclassification may have occurred in the case of one women who indicated on the questionnaire that she had an induced abortion, but whose medical records noted that she had actually had a miscarriage. This woman, who was in the 30-34 year age group, worked on the 18th floor of Tower I and conceived in 1986. She was not exposed to renovation during her pregnancy. Exclusion of this pregnancy from the analysis resulted in a slight underestimation of the miscarriage rate among women in Tower I.

VIII. CONCLUSION

NIOSH investigators concluded that compared to women who worked in Tower II, there was an elevated proportion of miscarriages among women who worked in Tower I, especially among those who conceived in 1988 and worked on the 14th or 15th floors. The precise cause of the miscarriage cluster could not be determined. Most likely, it was due to either chance or other factors that could not be specifically identified. While it is possible that pregnant women may have been exposed to construction-related reproductive toxins, we were unable to come up with a likely scenario by which this might have occurred.

A follow-up of 38 pregnancies conceived during the study period and ending after February 21, 1989 revealed that only 2 resulted in miscarriages, and that neither miscarriage occurred among women working on the 14th or 15th floors of Tower I.

Although a cluster of miscarriages appears to have occurred among women who conceived in 1988 and worked on the 14th or 15th floors of Tower I, an ongoing problem apparently does not exist.

IX. RECOMMENDATIONS

1. Building renovation work should be done, whenever feasible, during hours that

employees are not in their offices. This is especially important when known reproductive toxins or other hazardous materials are being used. If this is not feasible, employees should be temporarily relocated to areas away from renovation sites.

2. When renovation is done during regular working hours, precautions should be taken to avoid exposing office workers to airborne contaminants.
3. Although lead in the drinking water was not associated with miscarriages, measures should be instituted to reduce the amount of lead to levels within EPA recommendations.
4. If company and employee concerns about possible miscarriage excesses arise again, the USA Today/Gannett Co., Inc. Health/Workplace Task Force should consider instituting a pregnancy surveillance program, with the assistance of outside consultants.

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XII. DISTRIBUTION AND AVAILABILITY

Copies of this report are temporarily available upon request from: NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through: the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Copies of this report have been sent to:

1. USA Today/Gannett Co., Inc. Health/Workplace Taskforce.
2. Publisher of USA Today.
3. Virginia Department of Health.
4. OSHA Region III

For the purpose of informing affected employees, the report should be posted by the USA Today/Gannett Co., Inc. Health/Workplace Taskforce in prominent places that are accessible to employees, for a period of 30 calendar days.

TABLE 1

USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

DEMOGRAPHICS

A. ALL PARTICIPANTS

	<u>Current Employees</u>	<u>Former Employees</u>	<u>Overall</u>
Mean Age (Years)	32	32	32
Race (%)			
White	71	82	74
Black	24	15	22
Asian	3	1	2
Hispanic	1	2	2
Other	<1	0	<1
Education			
High School	7	7	7
Vocational/Technical	6	4	5
1-4 Years College	68	64	67
Graduate Work	21	25	21

B. WOMEN WHO HAD PREGNANCIES THAT BEGAN ON OR AFTER JANUARY 1, 1986
AND ENDED IN LIVE BIRTHS OR MISCARRIAGES BEFORE FEBRUARY 21, 1989

	<u>Current Employees</u>	<u>Former Employees</u>	<u>Overall</u>
Mean Age (Years)	32	31	32
Race (%)			
White	64	88	72
Black	28	8	21
Asian	9	0	6
Hispanic	0	4	1
Education			
High School	4	15	8
Vocational/Technical	11	0	7
1-4 Years College	64	73	67
Graduate Work	21	12	18

TABLE 2
USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

MISCARRIAGE PROPORTIONS

<u>Location</u>	<u>Pregnancies*</u>	<u>Miscarriages</u>	<u>Miscarriage Proportions**</u>
Tower I	52	18	35%
Tower II	14	2	14%
Outside I/II	18	7	39%
Overall	84	27	32%

* All Pregnancies (Excluding Stillbirths, Tubal Pregnancies,
Elective Abortions, and Pregnancies Occurring When Mothers
Were Not Employed)

** Miscarriages/Pregnancies x 100

TABLE 3

USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

1986-1989 PREGNANCIES, MISCARRIAGES, AND MISCARRIAGE PROPORTIONS:
BY YEAR OF CONCEPTION AND PLACE OF EMPLOYMENT

<u>Year</u> [#]	<u>Tower I</u>			<u>Tower II</u>			<u>Outside I/II</u>		
	<u>Preg.</u>	<u>*Misc.</u>	<u>**Prop.</u>	<u>Preg.</u>	<u>*Misc.</u>	<u>**Prop.</u>	<u>Preg.</u>	<u>*Misc.</u>	<u>**Prop.</u>
1986	15	3	20%	5	1	20%	6	1	17%
1987	21	5	24%	7	1	14%	6	3	50%
1988	16	10	63%	2	0	0%	6	3	50%
Overall	52	18	35%	14	2	14%	18	7	39%

Year of Conception

* All Pregnancies (Excluding Stillbirths, Tubal Pregnancies,
Elective Abortions, and Pregnancies Occurring When Mothers Were Not
Employed)

** Miscarriages

*** Miscarriage Proportion: Miscarriages/Pregnancies x 100

TABLE 4

USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

PREGNANCIES CONCEIVED IN 1988
AMONG TOWER I EMPLOYEES

<u>Floor</u>	<u>Pregnancies*</u>	<u>Miscarriages</u>	<u>Miscarriage Proportions**</u>
11	2	1	50%
12	1	0	0%
14	3	3	100%
15	5	5	100%
16	1	0	0%
18	2	0	0%
19	2	1	50%
Overall	16	10	63%

* All Pregnancies (Excluding Stillbirths, Tubal
Pregnancies, Elective Abortions, And Pregnancies
Occurring When Mothers Were Not Employed)

** Miscarriages/Pregnancies x 100

TABLE 5

USA TODAY/GANNETT CO., INC.
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THE ASSOCIATION BETWEEN MISCARRIAGES AND VARIOUS RISK FACTORS

UNIVARIATE ANALYSIS

<u>Factor</u>	<u>Relative Risk</u>	<u>95% CI</u>
Renovation	2.40	1.35-4.27
Conception in 1988	2.32	1.29-4.18
Age ≥ 35	2.30	1.30-4.08
Previous abortion	1.49	0.76-2.90
VDT use >20 hrs/wk	1.40	0.73-2.70
Smoking	1.14	0.52-2.49
Previous miscarriage	1.04	0.44-2.49
Stress	0.89	0.48-1.66

TABLE 6

USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

MEAN LEAD CONCENTRATIONS IN STANDING AND PURGED WATER

A. DRINKING FOUNTAINS

<u>TOWER</u>	<u>FLOOR(S)</u>	<u>STANDING WATER CONCENTRATION*</u>	<u>PURGED WATER CONCENTRATION*</u>
I	11,12,14,15,17,18,21,22	73**	45
II	22,25,28,31	173	53
I	14,15	20***	11***
I	11,12,17,18,21,22	85	55

* Parts Per Billion (PPB)

** Difference Between Tower I and Tower II
Statistically Significant, by Student's
T-Test ($p < .0001$)

***Difference Between Floors 14/15 and Other
Floors Statistically Significant, by Student's
T-Test ($p < .05$)

EPA 1975 Standard: ≤ 50 PPB EPA 1989 Recommendation: ≤ 20 PPB

B. RESTROOM FAUCETS, GALLEY SINK FAUCETS, AND ICE

<u>TOWER</u>	<u>FLOOR(S)</u>	<u>STANDING WATER CONCENTRATION*</u>	<u>PURGED WATER CONCENTRATION*</u>
I	11,12,14,15,17,18,21,22	26	20
II	22,25,28,31	123	22
I	14,15	22	5
I	11,12,17,18,21,22	27	23

* Parts Per Billion (PPB)

FIGURE I

Miscarriages in Tower I

1986-1989

By Year of Conception

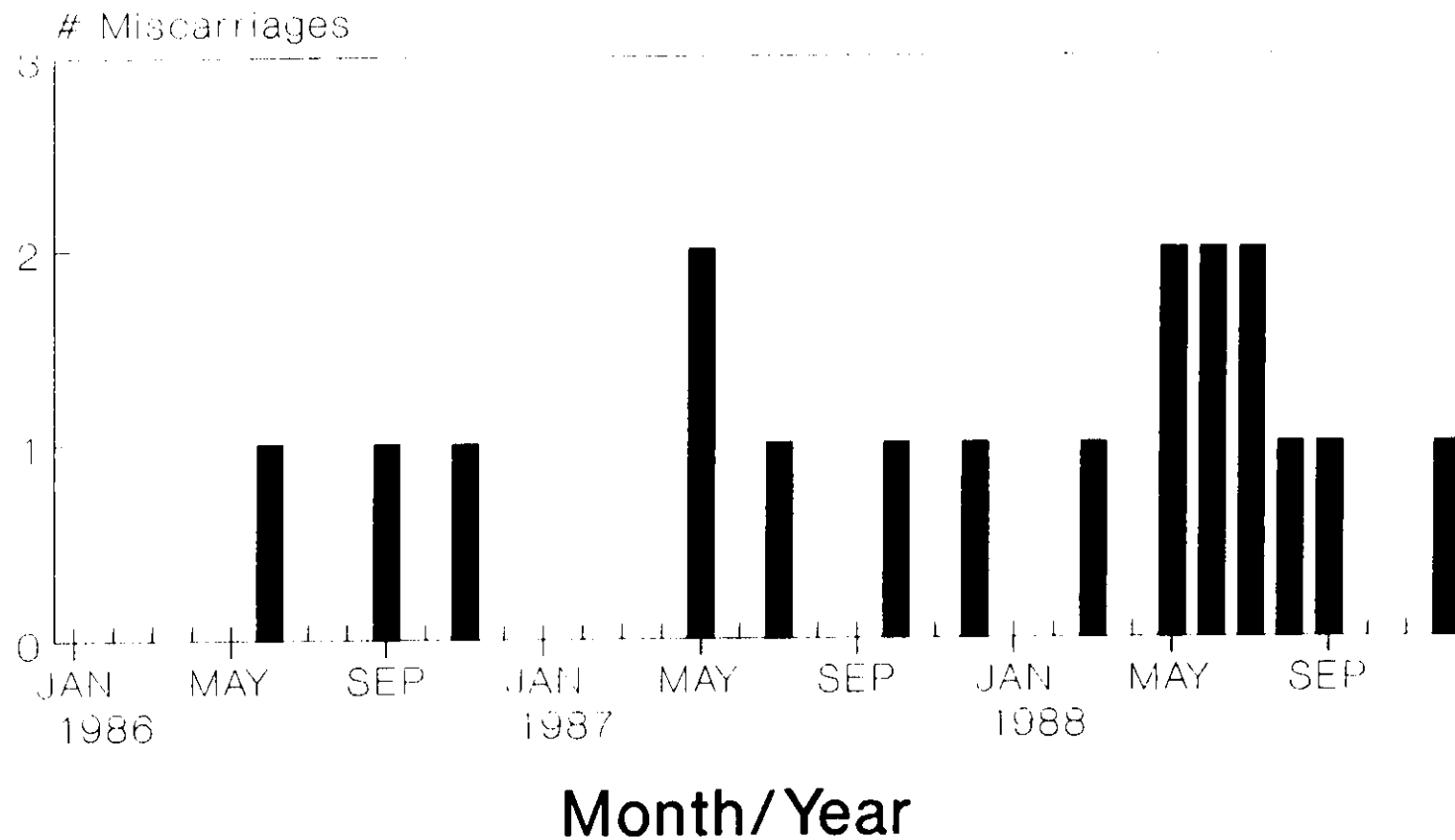


FIGURE 11

QUALITATIVE ORGANIC VAPOR RESULTS, CONTAINMENT AREA

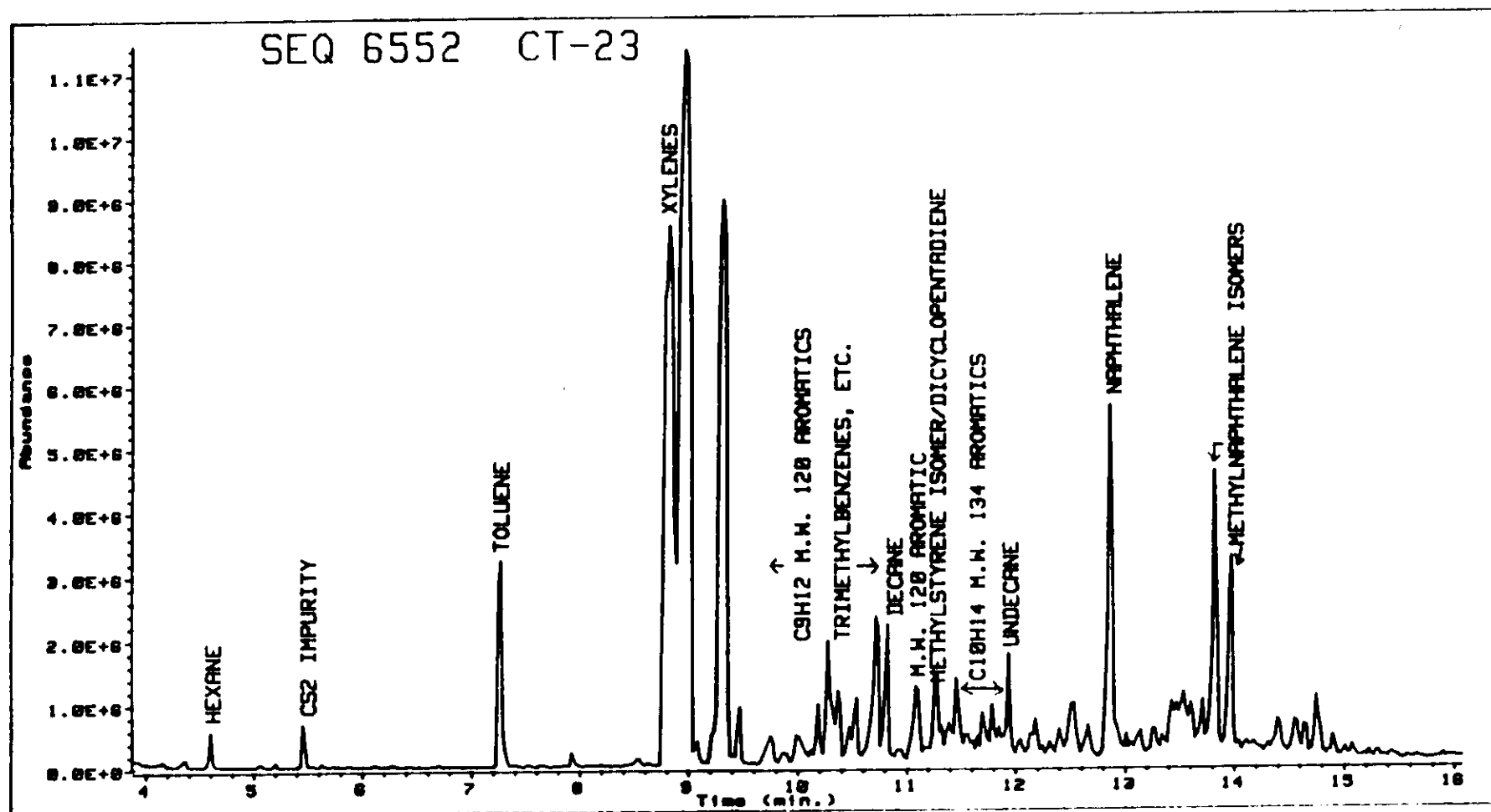
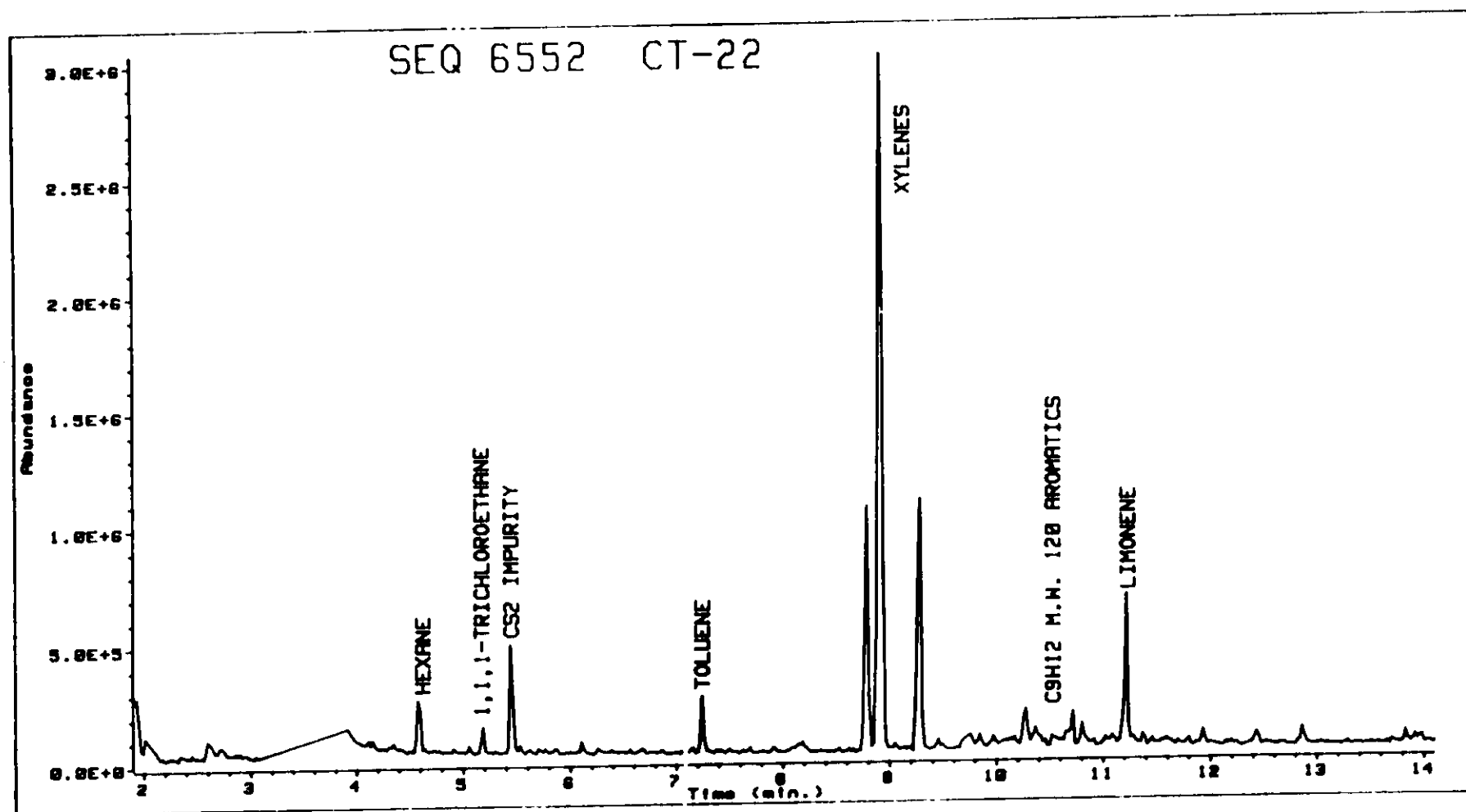


FIGURE 111

QUALITATIVE ORGANIC VAPOR RESULTS, 12TH FLOOR/OUTSIDE CONTAINMENT AREA



APPENDIX I

USA TODAY/GANNETT CO. INC.
ROSSLYN, VIRGINIA
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SUMMARY OF SAMPLING AND ANALYTICAL METHODS

COMPOUND	METHOD NUMBER	COLLECTION MEDIA DESCRIPTION	ANALYSIS
2-Ethoxyethanol	NIOSH 1403	Charcoal tube	GC/FID
Xylene	NIOSH 1501	Charcoal tube	GC/FID
Diethylenetriamine	OSHA 60	XAD-2 tube	HPLC/UV
Dibutylphthalate	NIOSH 5020	MCE filter	GC/FID
Methylenedianiline	NIOSH research method	Acid-treated GF filter	LC/UV-ED

MCE filter: mixed cellulose ester filter

GF filter: glass fiber filter

GC/FID: gas chromatography/flame ionization detector

HPLC/UV: high pressure liquid chromatography/ultraviolet detector

LC/UV-ED: liquid chromatography/ultraviolet-electrochemical detector

APPENDIX II

USA TODAY/GANNETT CO., INC.
ROSSLYN, VIRGINIA
HETA 89-069

EVALUATION CRITERIA

In order to evaluate the hazards posed by chemicals in the workplace, NIOSH investigators use "evaluation criteria." These criteria are intended to suggest airborne levels of chemicals to which most employees can be exposed for up to 10 hours per day, 40 hours per week (over a working lifetime), without experiencing adverse health effects.

It is important to note, however, that not all employees will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience problems because of individual susceptibility or pre-existing medical conditions. In addition, (1) some hazardous chemicals may act in combination with other workplace exposures to produce adverse health effects (even at levels below those set by the criteria), and (2) exposure to some chemicals may be increased via dermal and mucous membrane absorption. Finally, environmental criteria can change over the years as new toxicologic information becomes available.

The primary sources of evaluation criteria for the workplace are: (1) NIOSH's Recommended Exposure Limits (RELs), (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and (3) the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limits (PELs). By law, employers must comply with OSHA PELs.

Evaluation criteria are usually based on time-weighted averages (TWAs), which refer to average airborne concentrations of chemicals during normal 8-10 hour workdays. Sometimes, there are additional short-term exposure limits (STELs) or ceiling limits, which are intended to supplement TWA's when there can be toxic effects from high, short-term exposures.